Celanese Chemicals Clear Lake Plant Energy Projects Assessment and Implementation

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Abstract

The Clear Lake Plant of Celanese Chemicals has implemented a strategy to reduce energy consumption. The plant identified, designed, and completed several projects to improve its chemical production processes. These projects reduced steam use, fuel gas use, and electricity use. Some involved capital changes, but most used existing assets more efficiently. Celanese now realizes cost savings while operating a more efficient and reliable plant.

Introduction

The Clear Lake Plant pursued a strategy to reduce energy use in two stages. The first stage was a part of its Low Cost Producer program. The plant conducted a series of brainstorming meetings to generate ideas to reduce production costs, including energy costs. Teams of engineers and specialists reviewed the ideas to refine them into potential projects.

The second stage of the strategy was to construct a predictive model of the plant's steam and energy transfer systems. The purpose of this was to reduce or avoid inefficiencies resulting from breaking down high pressure steam over valves, venting steam, and losing water. The model considers fuel gas and electrical usage and billing rates from suppliers. The model anticipates the effect of a proposed change in one area, on the overall energy balance of the plant. From the potential projects proposed in the first stage, the predictive model helped to select the most beneficial ones to pursue.

The Clear Lake Plant expects reduced energy use (adjusting for plant expansion projects), especially in steam and fuel gas. Preliminary data from 1999 over 1998 shows improvement, most of which can be attributed to several projects. Most projects involved no capital expenditure; some took advantage of existing equipment or scheduled equipment replacements to design a more energy-efficient system.

Examples of Completed Projects

Heat Exchanger

One of the plant's processes includes a byproduct removal system, consisting of an absorber tower and a stripper tower, with a process-to-process exchanger between two of the streams. Over the years, the interchanger performance had deteriorated slowly, due to fouling and corrosion. Process modeling showed that about 50Mlb/hr of steam driving the stripper reboiler could be reduced by replacing the old exchanger. The unit replaced the exchanger with one similar in size, with new cleaning nozzles and redesigned baffles. The project reduced low-pressure steam used in the stripper, amounting to 2.5 percent of the plant energy load.

Use Excess Process Steam for Heat Recovery

Another process generated steam containing a small amount of process material. This could not go directly into the plant steam system, so the excess steam was vented. In a separate process, purchased steam heated a Flasher vessel. To improve this situation, the unit implemented a low-cost project to add piping. The process steam was lined up to the Flasher reboiler, which recovered the heat and condensed the steam. The resulting condensate went to wastewater treatment. This displaced purchased steam from the reboiler, saving at least 0.5 percent of the plant steam load.

Use a Single Incinerator Instead of Two

In one process, two incinerators were operated for liquid and vent wastes. The second backed up the first incinerator, burning fuel gas for warm standby. This avoided having to trip out the process reactors in the case that the first incinerator tripped out, affecting reliability and lost production time. A study found that trip-outs of the incinerator were less frequent than expected. Therefore, it was more economical to use only one incinerator. Eliminating the hot standby resulted in large fuel gas savings of $1 million per year.

Run a Distillation Tower Only Part-Time

A plant process had a distillation tower to recover a byproduct from a product stream. Previously, it had run all the time, but at fairly low rates. Now the unit manages the inventory so that the tower operates only part of the time, for 10 to 15 days per month. For the other 15 to 20 days per month, the tower shuts down. This saves on reboiler steam, cooling water, and some electricity savings.

Redesign of Exchangers

Another process has exchangers to recover excess heat from a vapor phase reaction product stream. The exchangers consist of a large helical tube inside a shell, with the process material on the tube side and the boiler feed water heating to steam on the shell side. For this project, the exchangers were redesigned to give more heat transfer overall. Therefore, the plant recovers more byproduct steam. This is an example of a project which started as a debottlenecking project, but also recovers energy.

Optimize Tower Operation

There are several projects under way to optimize the operation of distillation towers. Using one tower project as an example, operations decreased reflux, changed tray temperatures and tower pressures, and decreased reboiler steam. Although the savings can vary with rate changes in the process, this project alone can save 0.4 percent of the plant steam load.

Improve Process Control of Large Air Compressor

Engineers improved process control for a large air compressor which feeds a reaction train. To improve efficiency, the new control strategy minimized the differential pressure across the flow control valve downstream of the compressor. In order to open up the flow control valve more, the air discharge pressure of the compressor was reduced by lowering the speed of the compressor. This resulted in saving the high-pressure steam which powered the compressor.

Eliminate Hot Standby for Utilities Boilers

Previously, two boilers ran and a third was on standby. The third burned fuel gas to keep the tubes warm, in case the other boilers tripped. Later a study determined that the reliability of the other boilers was good enough to run without a spare, so the standby was then eliminated. This saves about $640,000 per year on fuel gas, 2 percent of the plant's energy budget.

Implement a Range of Smaller Projects

The plant also implemented several smaller energy-saving projects. Eliminating hot standby for spare turbines, shutting down outmoded process systems, and optimizing pump impeller usage are some examples. Other projects made better use of steam by adding lines to transfer it where it was needed. The plant changed tower operation to use lower-pressure steam when possible. On a continual basis, the plant makes choices to operate equipment with turbines or with motors.

Conclusion

The Clear Lake Plant has achieved reductions in energy usage by selecting and implementing projects which required little capital expenditure. These changes are expected to improve overall energy productivity. Often energy reductions occur hand-in-hand with efficiency, productivity, and reliability improvements.